
2050 Study on Transportation Technology and Fuels: Draft Technology Cost Resource Paper

Prepared for:

U.S. Department of Energy
Office of Planning, Budget Formulation & Analysis



September 2002

Prepared by:

James S. Moore, Jr., P.E.

TA Engineering, Inc.

Technical Analysis and Engineering

405 Frederick Road

Suite 252

Baltimore, Maryland 21228

(410) 747-9606 (phone)

(410) 747-9609 (fax)

j.moore@ta-engineering.com

Table of Contents

1.0	Introduction	1
2.0	Background	1
3.0	Approach	2
3.1	National Research Council Study	3
3.2	Moore's Law	3
3.3	Other	6
4.0	Results	8
5.0	References	10

Appendix

Greening the Pump

Vehicle Technology Cost Projections-Autos	A-1
Vehicle Technology Cost Projections-Light Trucks	A-2
Vehicle Technology Cost Projections-Class 3-6 Trucks	A-3
Vehicle Technology Cost Projections-Class 7-8 Trucks	A-4

Go Your Own Way

Vehicle Technology Cost Projections-Autos	A-5
Vehicle Technology Cost Projections-Autos	A-6
Vehicle Technology Cost Projections-Light Trucks	A-7
Vehicle Technology Cost Projections-Light Trucks	A-8
Vehicle Technology Cost Projections-Class 3-6 Trucks	A-9
Vehicle Technology Cost Projections-Class 7-8 Trucks	A-10

List of Exhibits

- Exhibit 1: Hybrid Fuel Economy and Cost Table
- Exhibit 2: Preliminary Cost Performance Analysis of Hybrid Electric Technology Auto
- Exhibit 3: Normalized Graph of NRC Fuel Economy – Cost for Autos
- Exhibit 4: Normalized Graphs of NRV Fuel Economy – Cost for Light Trucks
- Exhibit 5: Moore’s Law
- Exhibit 6: Effect of Moore’s Law on Cost
- Exhibit 7: Proposed Hybrid-Electric Auto Cost Curves
- Exhibit 8: Proposed Transportation Technology Cost Deflator with Assuming a Ten Year Performance Interval
- Exhibit 9: Purchase Cost of Class 3 through 6 Trucks
- Exhibit 10: Natural Gas-Fueled Bus Purchase Costs

1.0 Introduction:

This paper describes the analysis approach and findings of a study of vehicle technology cost trends that can be anticipated during the next fifty years. This work is part of a comprehensive assessment of future transportation fuels and technologies that may compete in the North American market during a period of transition from conventional petroleum-based fuels.

The scope of the effort is limited to highway vehicles: autos, light trucks, medium and heavy trucks, and buses. Technologies considered include:

- Conventional ICE (spark ignited using gasoline, ethanol-based, and natural gas fuels)-
- Diesel-
- Hybrid-electric- and
- Fuel cell (hydrogen-fueled)-

energy conversion systems.

This is the draft resource paper. It contains a background discussion of how this work relates to other parts of the 2050 Study on Transportation Technology and Fuels. Information collection efforts are reviewed as well as the approach to presenting relationships between changes in fuel economy and changes in (vehicle) technology cost. Preliminary results of estimates of the cost of the alternative technologies are presented.

2.0 Background:

The 2050 Study on Transportation Technology and Fuels was undertaken, in part to expand on prior investigations on the long-term outlook for highway transportation systems and fuels in the US (Ref. 1). Based on similar interests of Natural Resources Canada, the scope of the current effort was broadened from an analysis of the US market to address the North American continent. The project scope also embraced the use of scenarios to identify alternative futures that could reasonably be anticipated to occur.

A base case and three alternative scenarios were defined. These are described in another resource paper. The current effort also expanded on the Reference 1 evaluation of both North American and world energy resources; with emphasis on conventional oil, unconventional oil (especially Oil Sands), and natural gas. This included the development of a World Oil Model to determine the effects of various resource, production and consumption trends on future world oil prices.

Several reviewers of the Reference 1 study identified the need to estimate the cost associated with transitions from current transportation technology and fuels. The work reported in this resource paper is part of the study's response to that need. Other work is addressing costs associated with production and infrastructure development of hydrogen, ethanol, and unconventional oil. These costs are being combined in another model to determine aggregate costs to accomplish the transitions from petroleum fuels for the assumptions of the reference case and three scenarios.

3.0 Approach:

The approach involved developing technology cost vs fuel economy curves for each technology and scenario. As the starting point for the development of these curves, prior work by Santini, who reported cost/performance in terms of percentage improvement in fuel economy vs. percentage increase in cost, was reviewed (Ref. 2). Investigations resulted in additional data points being added. The added data points were extracted principally from two sources (Refs. 3 & 4).

Exhibit 1 lists the tabular information that formed the basis of the hybrid-electric vehicle analysis. The incremental cost and fuel economy improvement values were initially plotted as a single data series, as is shown in Exhibit 2.

Exhibit 1: Hybrid Fuel Economy and Cost Table

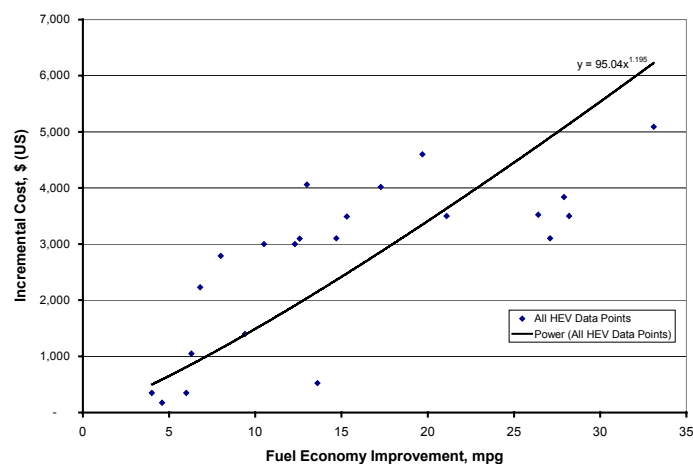
Baseline or Comparison Technology	Technology Category	Source	Advanced Technology	Cost Increase, \$	Fuel Economy Increase, mpg	% Fuel Economy Improvement	Base mpg	Step mpg	Base l/100km	Step l/100 km	Base \$
Diesel	Mid-size, Small Battery	ADL	HEV-Diesel	200	4.0	10%	41.0	45.0	5.73	5.22	12,000
Diesel	SUV, Large Battery	ADL	HEV-Diesel	300	2.8	10%	27.5	30.3	8.55	7.76	16,100
SI-Advanced Mid-size	Mild	ACEEE	HEV- Mid-Size	2,230	6.8	15%	45.8	52.6	5.13	4.47	20,827
Diesel	Mid-size, Small Battery	ADL	HEV-Diesel	1,600	8.0	20%	41.0	49.0	5.73	4.80	12,000
Diesel	SUV, Small Battery	ADL	HEV-Diesel	200	6.1	22%	27.5	33.6	8.55	7.01	16,100
SI	SUV, Small Battery	ADL	HEV-SI	100	4.6	22%	20.9	25.5	11.25	9.22	14,900
SI	Mid-size, Small Battery	ADL	HEV-SI	600	7.0	23%	30.0	37.0	7.84	6.35	11,000
SI-low tech powertrain	SI	ANL	HEV-Full	4,018	17.3	53%	32.3	49.6	7.27	4.74	22,933
SI-low tech powertrain-8 sec.	Mild	ANL	HEV-Mild	3,100	14.7	55%	26.9	41.6	8.74	5.65	25,100
SI		Greene-OTA	HEV-SI	3,000	10.5	36%	29.4	39.9	8.00	5.89	
SI-Cont. Low Load car		EPRI	HEV-EPRI	4,058	13.0	45%	28.9	41.9	8.13	5.61	18,984
SI-low tech powertrain	Mild	ANL	HEV-Mild	3,098	12.6	39%	32.3	44.9	7.27	5.24	22,933
SI-low tech powertrain-8 sec.		ANL	HEV-Full	4,600	19.7	73%	26.9	46.6	8.74	5.05	25,100
SI		Greene-OTA	HEV-SI	3,000	12.3	42%	29.4	41.7	8.00	5.63	
SI	SUV, Large Battery	ADL	HEV-SI	800	9.4	45%	20.9	30.3	11.25	7.76	14,900
SI	Mid-size, Large Battery	ADL	HEV-SI	2,000	16.0	53%	30.0	46.0	7.84	5.11	11,000
Diesel		Greene-OTA	HEV-Diesel	3,500	21.1	54%	39.1	60.2	6.01	3.90	
Diesel		Greene-OTA	HEV-Diesel	3,500	28.2	72%	39.1	67.3	6.01	3.50	
SI		EPRI	HEV-EPRI	3,837	27.9	80%	34.8	62.7	6.76	3.75	18,984
SI-Baseline	ICE	MIT	HEV-SI	3,100	27.1	63%	43.2	70.3	5.44	3.34	18,000
SI-2000 Taurus SE	Mild	ACEEE	HEV- Mid-Size	3,522	26.4	101%	26.2	52.6	8.97	4.47	19,535
SI-2000 Taurus SE		ACEEE	HEV, Full-Mid Size	5,089	33.1	126%	26.2	59.3	8.97	3.96	19,535

References 2 to 5

Based on discussion and reviews with the overall study team, the use of an exponential regression technique was recommended, so that the curves would originate from the origin of a graph.

The Transportation Technology and Fuels analysis is being developed with the use of a base case and three scenarios. The scenarios reflect differing fuel economy performance as influenced by three discrete drivers: innovation, environmental responsiveness, and level of North American energy market interdependence.

Exhibit 2: Preliminary Cost Performance Analysis of Hybrid Electric Technology Auto



These scenarios result in varying mixes of advanced technology vehicles, which presumably reflect different cost-performance relationships.

The ‘**Greening the Pump**’ scenario reflects environmental concerns and a high degree of North American energy market interdependence. The relative lack of innovation is interpreted as resulting in little push for expensive, highly efficient transportation technologies, but there will be some level of market acceptance of investment in options that reduce environmental degradation. Most of the transitions that occur within this scenario occur within the first thirty years.

‘**Go Your Own Way**’ is influenced by innovation and environmental responsiveness. This scenario offers the market situation that is the most favorable to advanced vehicle technologies and alternative fuels. As a result the full array of technologies considered in the study compete in the market.

‘**Rollin On**’ is influenced by innovation and North American energy market interdependence. The situation should be favorable to the availability of traditional fuels, or new fuels that are similar to traditional fuels. These conditions may discourage the market acceleration of alternative vehicle technologies—which should result in costs per unit fuel economy gain that are higher than in an environment favorable to more widespread market acceptance of the advanced technologies. The cost analyses for Rollin On are in progress.

3.1 National Research Council Study

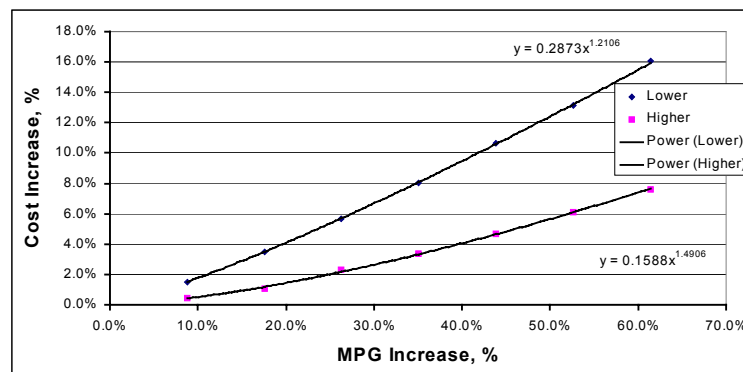
The analyses of literature sources examining the relationship between fuel economy and cost on a technology-specific basis resulted in the identification of relationships with varying levels of analytic consistency. Data for internal combustion engine vehicles and diesel engine vehicles, for example showed relatively consistent patterns. Fuel cell vehicle technology cost analyses were more problematic to evaluate. While several sources have evaluated expected fuel cell vehicle performance and cost, an attempt to plot the relationships and analyze them resulted in very low correlations or highly non-intuitive results (Refs. 6 to 11).

The report of a recent study by the National Resource Council was useful in providing consistent relationships (Ref. 12). As part of this study, the analyses of several organizations were reviewed. The report presents lower and higher fuel economy curves representative of autos and light trucks. These curves were normalized and re-plotted to illustrate percentage improvements in fuel economy and increases in cost. These relationships are indicated in Exhibits 3 and 4.

3.2 Moore’s Law:

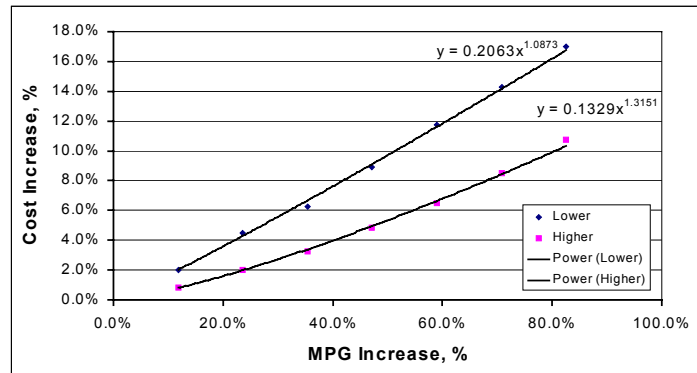
As described above, the alternative scenarios of the study identify futures with varying levels of innovation and market acceptance of the advanced technologies. As a result, a requirement was

Exhibit 3:
Normalized Graphs of NRC Fuel Economy—Cost for Autos



identified for the technology cost analysis to model breakthroughs or other market events that resulted in improved technology production efficiency and reduced cost.

Exhibit 4: Normalized Graphs of NRV Fuel Economy—Cost for Light Trucks



A theory to explain semi-conductor industry cost trends was examined to provide a generalized model of cost trends showing step-level changes. Gordon Moore of Intel developed a theory to describe changes in semiconductor chip density with time (Ref. 13). “Moore’s Law” is expressed as follows:

$$\text{Circuits per chip} = 2^{(\text{year}-1975)/1.5}$$

The equation expresses a projection that chip density would double every eighteen months. In the context of semiconductors and integrated circuits, density is directly linked to cost—so an increase in density results in a commensurate decrease in cost. This hypothesis has been largely borne out in the ensuing years and has become the subject of subsequent considerable analysis and discussion.

Exhibit 5 illustrates in tabular and graphical form, the effect of this law on circuit density.

Exhibit 5: Moore’s Law

Equation:

$$\text{Circuits per chip} = 2^{(\text{elapsed time in years})/1.5}$$

1.0	0
1.6	1
2.5	2
4.0	3
6.3	4
10.1	5
16.0	6
25.4	7
40.3	8
64.0	9
101.6	10

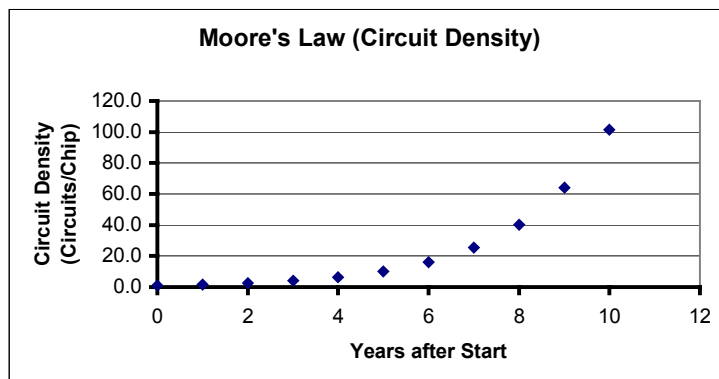
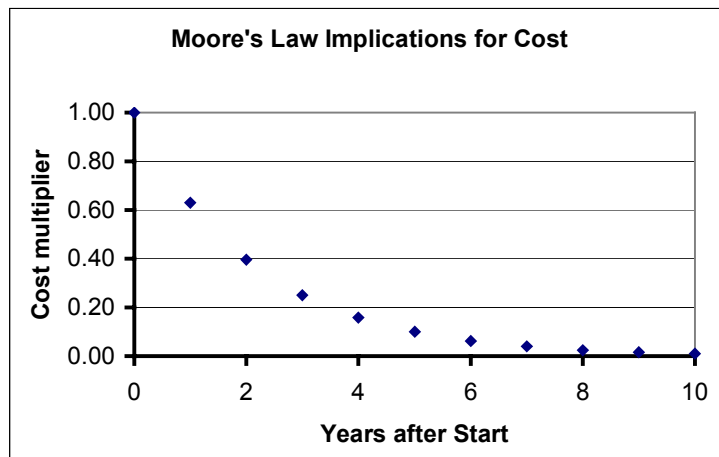


Exhibit 6 below, is based on Moore’s Law, but expresses the efficiency improvement as a cost reduction effect. This was done by changing the exponent from positive to negative, but maintaining the same relationship.

Exhibit 6: Effect of Moore's Law on Cost

Multiplier Effect on Cost to Produce Chips	
1.00	0
0.63	1
0.40	2
0.25	3
0.16	4
0.10	5
0.06	6
0.04	7
0.02	8
0.02	9
0.01	10



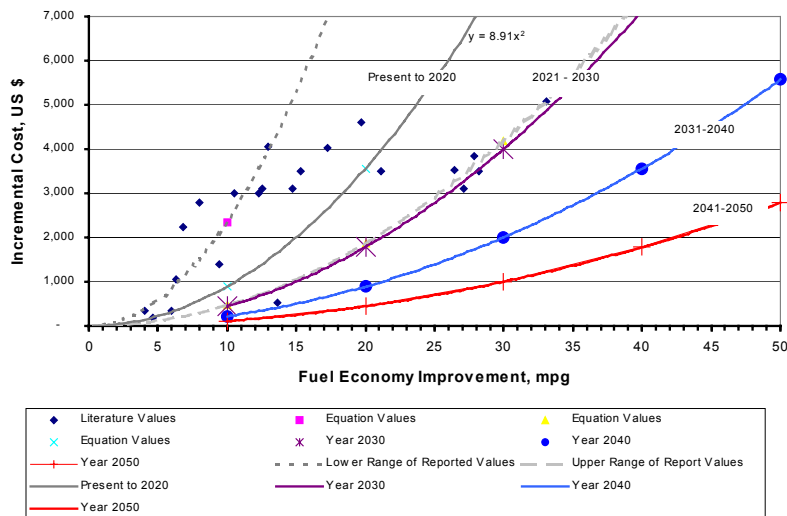
Reference 13 contains a discussion of growth and efficiency gains in other industries. It is observed that Moore's Law is being considered in a broader context as an explanation for technological progress. The author considers historical examples. For example it is noted that the rail industry doubled its track capacity during two ten-year periods in the early 1800s, but that expansion in the transportation sector eventually shifted to the auto.

The cost values for Hybrid-Electric autos were evaluated in this context. The approach involved developing a single fuel economy gain vs. incremental cost curve from the estimates in the literature to represent the 'Present to 2020'. This coincides with the time

period of applicability for the cost references that have been reviewed. Then, using an equation based on Moore's Law (relative to cost reduction) show how the near term (Present to 2020) curve would change for future time periods. This approach and results are indicated in Exhibit 7.

Literature values are plotted on the graph. Two quadratic equations were plotted to indicate the upper and lower limits of the literature values. These lines are shown in dotted form. The average of these two "extremes" was determined and plotted as the fuel economy vs. cost curve for the period from the present to 2020.

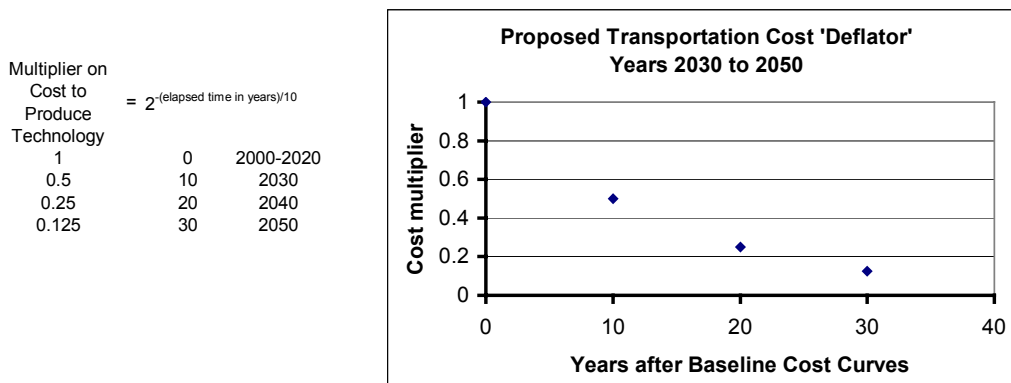
**Exhibit 7:
Proposed Hybrid-Electric Auto Cost Curves**



As shown on the graph, the proposed curve for the present to 2020 is of the form $y=8.91x^2$.

Exhibit 7 also shows proposed curves for Years 2030, 2040, and 2050. These were developed by applying a multiplier determined by using the equation based on Moore's Law as applied to technology cost. In particular, a ten-year period to achieve a halving in cost was assumed. This assumption has the effects indicated in Exhibit 8.

Exhibit 8:
Proposed Transportation Technology Cost Deflator with Assuming a Ten Year Performance Interval



The multipliers shown in Exhibit 8 were applied to the ‘Present to 2020’ curve in Exhibit 3 to develop the future time period curves.

As noted above, Reference 13 indicates that Moore's Law can be applied to consider the effects of innovation in a manufacturing context. As a result, one item for consideration was how to model the varying effects of innovation in the three scenarios of the 2050 Study. A doubling of manufacturing efficiency (or halving of cost) every ten years reflects a high degree of innovation for the transportation sector. The Exhibit 7 cost curves were considered as applicable to the high-innovation ‘Go Your Own Way scenario’. The ‘Greening the Pump’ scenario has a lower level of innovation, with most of the changes occurring within the first thirty years. As a result, a cost reduction was assumed to occur after the first thirty years—in 2031.

3.3 Other

The cost analysis also addressed medium trucks, (Class 3 through 6), heavy trucks (Classes 7 and 8), and Buses. Initial purchase costs used to represent medium trucks are shown in Exhibit 9.

Class 3 – 6 Trucks

Near term purchase costs for medium trucks were developed using the values in Exhibit 9. These were extracted from Reference 14 (TEDB) along with sales percentages for each class.

Exhibit 9: Purchase Cost of Class 3 through 6 Trucks

Weight Class	Low	High	Average	Percent of Sales
Class 3, \$	26,000	30,000	28,000	48.0%
Class 4, \$	33,200	40,000	35,467	19.3%
Class 5, \$	33,000	41,000	36,450	11.9%
Class 6, \$	35,000	51,000	44,150	20.9%
Sales Weighted Average Cost, \$	30,100	37,623	33,818	--

Class 7 & 8 Trucks

A search of web sources was performed to identify current purchase costs. Class 7-8 trucks typically consist of two units—the tractor; the lead unit or cab, which provides the motive power; and the trailer, the trailing unit that carries the freight. Tractors are manufactured by several firms, and are custom specified based on several characteristics such as wheel base length, engine size, transmission, manufacturer, whether or not they include sleeping space, and size of sleeping compartment. Some units are selected for specialized duty, such as bulk hauling and dumping, while others are selected for general over the road freight trips.

Due to the diversity in vehicle characteristics and application requirements prices vary widely. From the web search, prices for Kenworth units were the most readily available (Ref. 15). Prices in U.S. dollars range from \$105,000 to \$49,500. Units that appeared to be set up for interstate freight hauling with sleeping quarters are mostly in the \$100,000 range. Information was obtained for several units for sale in Canada. These covered a range of \$148,500 Canadian to \$65,700. Prices in the \$114,500 and greater appear to be the range for long haul freight units. The currency conversion from Canadian to U.S. dollars, must be applied to use Canadian truck price data together with the US vehicle prices.

The price ranges noted above, are based on specific examples for 2002 models, but they appeared on a website (Ref. 15). Most were shown as having zero to less than 100 miles, which is indicative of a new vehicle, but they may have been specified by users that cancelled the sale or vehicles that; while not used, were previously sold.

Trailers are specified and sold separately. They, too, come in a variety of configurations; e.g. size (length) and type (van, moving van, refrigerated, and other specialized versions). One web site for used conventional freight trailers showed a range of \$19,700 to \$20,500 (Ref. 16). These prices were for 2001 models. There was no other information available on the web site about usage level. Presumably these costs are marginally lower than those for 2002 “new” models.

Based on these investigations, the recommended purchase costs for current technology Class 7 and 8 trucks (and trailers) is \$130,000 (US).

Buses

Estimates for buses are presented in Exhibit 10. As the table indicates, four categories were investigated to illustrate the range of configurations:

- Articulated-transit buses
- Intercity
- Transit (40ft.), and
- School Bus (50-passenger).

One Source used was the American Public Transit Administration (APTA) web site. Cost of 40 ft. transit buses is \$288k. (Ref. 17). Independently the Mass Transit Administration of the MTA said they budget \$285k for forty-foot units, which is good confirmation (Ref 18). The NGV Coalition purchasing guide showed a range of costs for 40 ft. transit buses as shown in the table. The average was used to represent the natural gas premium cost (Ref. 19).

**Exhibit 10:
Natural Gas-Fueled Bus Purchase Costs**

Bus Type	Estimated Cost, \$	Natural Gas Option, \$		Natural Gas Option, Average, \$	Natural Gas Premium Estimate, \$	COMMENTS
		Low	High			
1 Articulated (55'-60')	438,000	Not Available		119,100	318,900	Natural gas option estimate based on ratio of the premium for 40' transit buses to cost of conventional 40' buses.
2 Intercity (35'-45')	364,000	Not Available		99,000	265,000	Natural gas option estimate based on ratio of the premium for 40' transit buses to cost of conventional 40' buses.
3 Transit (40')	285,000	290,000	435,000	362,500	77,500	Natural gas option costs from "2002 Natural Gas Vehicle Purchasing Guide", NGV Coalition, 2002.
4 School Bus (~50 Passenger)	65,000	90,000	130,000	110,000	45,000	Natural gas option costs from "2002 Natural Gas Vehicle Purchasing Guide", NGV Coalition, 2002.

Comparable values for natural gas buses were not available for articulated and intercity, so the ratio of the natural gas premium to the conventional bus cost for 40 ft. transit buses was used for those two categories.

4.0 Results

Preliminary results have been generated for the Greening the Pump and Go Your Own Way Scenarios. These are presented in the Appendix.

The tables present the results of the cost analysis for autos, light trucks, medium trucks and heavy trucks. Fuel economies in miles per gallon (mpg) for each year of the analysis period are indicated for each technology that is assumed to compete in the respective scenarios. Based on the 'mpg improvement vs. cost' relationships discussed previously, incremental cost of the technologies are presented in both percentages and cost (dollars). The assumed initial cost of the technologies (year 2005 or time of initial introduction) are also indicated. Incremental cost increases are added to the 2005 costs so that total technology cost in dollars (US, per vehicle) are indicated.

As discussed previously, the Go Your Own Way Scenario is based on a high level of technological innovation. As a result, this scenario allows all technologies to compete: Diesel, Hybrid-electric, and fuel cell vehicles; in addition to conventionally-based ICE spark-ignition engine vehicles.

In the Greening the Pump scenario, Diesel and Hybrid-electric technologies compete with conventional ICE. Liquefied Petroleum Gas (LPG) and Compressed natural gas autos and light trucks are assumed to have the same price. LNG heavy trucks are also used. In some cases, fuel economy projections are somewhat less aggressive than for Go Your Own Way.

The most significant difference in the cost results between the scenarios is the assumption concerning step improvements (changes in equation coefficients). In particular, the Appendix tables for the Go Your Own Way scenario consistently show that the additional costs reduce to little more than the conventional vehicles during the 2041 to 2050 time.

The development of costs for technologies and fuel economy performance in the Rolling On scenario is in progress and will be included in the final resource report.

5.0 References:

1. Birky, et al; Future US Highway Energy Use; A Fifty Year Perspective (Review Draft), May 3, 2001
2. Personal Communication with D. J. Santini, ANL; October 8, 2001
3. "On the Road in 2020, A Life-cycle Analysis of New Automobile Technologies", MIT Report No. MIT EL 00-003, October 2000
4. "Guidance for Transportation Technologies: fuel Choice for Fuel Cell Vehicles", Arthur D. Little, Inc., Report No. 35340-00, February 6, 2002
5. "Engineering-Economic Analyses of Automotive Fuel Economy Potential in the United States", Greene, D. L. and DeCicco, J., ORNL/TM-200/26, January 2002
6. "Social Cost Comparison Among Fuel Cell Vehicle Alternatives", Contadini (ICS-UC Davis)
7. "A Critical Evaluation of Electric Vehicle Benefits", Litman (Victoria Transport Policy Institute), Nov. 1999
8. "Integrated Analysis of Hydrogen Passenger Vehicle Transportation Pathways", Davis et al (DTI), March 1998
9. "Integrated Analysis of Hydrogen Passenger Vehicle Transportation Pathways", Davis et al (DTI), March 1998
10. "Technical and Economic Assessment of Hydrogen as a Fuel for Fuel Cell Vehicles", Ogden et al, 1998
11. "Program Analysis Methodology—Quality Metrics 2002", DOE-OTT, May 2001
12. "Effectiveness and Impacts of Corporate Average Fuel Economy Standards," National Research Council, National Academy Press, Washington, D.C, Mo, 2002
13. Schaller, B., "The Origin, Nature, and Implications of Moore's Law; The Benchmark of Progress in Semiconductor Electronics", <http://mason.gmu.edu/~rschalle/moorelaw.html>.
14. "Transportation Energy Data Book" (Edition 21), Stacy C. Davis (Oak Ridge National Laboratory), ORNL 6966, October 2001
15. www.usedtrucklocator.com, PACCAR Financial New and Used Truck Locator, March 2002
16. www.truckpaper.com, March 2002
17. www.apta.com/stats/vehicles/busmkt3.htm American Public Transit Administration, Washington, DC, August 2002
18. Personal communication between Frank Fulton, Maryland MTA and K. Moore, TA Engineering, August 16, 2002
19. "2002 Natural Gas Vehicle Coalition Purchasing Guide", The Natural Gas Vehicle Coalition, Washington, DC 2002

Appendix

**Vehicle Technology Cost Projections--Autos
Greening the Pump**

YEAR	ICE--Gasoline & Alt. Fuels (alcohol)						Diesel						Hybrid Electric				Gaseous fuel vehicles (LPG/CNG)		COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$ x 1000	Total Technology Cost, US \$	Fuel Economy, mpg	Incremental Fuel Economy Improvement, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Fuel Economy, mpg		
	28.50	--			23,000						24,500		38.48				See Scenario data - values only spreadsheet		Baseline Values
2005	28.50	0.00	0%	0.0%	0	23.0	37.65	9.15	32%	1.6%	386	24.9	38.48	10	35%	6.7%			
2006	28.50	0.00	0%	0.0%	0	23.0	37.54	9.04	32%	1.5%	377	24.9	39.05	11	37%	7.4%			
2007	28.50	0.00	0%	0.0%	0	23.0	37.43	8.93	31%	1.5%	368	24.9	39.62	11	39%	8.3%			
2008	28.50	0.00	0%	0.0%	0	23.0	37.33	8.83	31%	1.5%	359	24.9	40.19	12	41%	9.1%			
2009	28.50	0.00	0%	0.0%	0	23.0	37.22	8.72	31%	1.4%	350	24.9	40.76	12	43%	10.0%			
2010	28.50	0.00	0%	0.0%	0	23.0	37.11	8.61	30%	1.4%	342	24.8	41.33	13	45%	11.0%			
2011	29.04	0.54	2%	0.0%	10	23.0	37.69	8.65	30%	1.4%	332	24.8	42.42	13	46%	11.5%			
2012	29.58	1.08	4%	0.1%	28	23.0	38.27	8.69	29%	1.3%	323	24.8	43.52	14	47%	12.1%			
2013	30.12	1.62	6%	0.2%	51	23.1	38.84	8.72	29%	1.3%	314	24.8	44.61	14	48%	12.6%			
2014	30.66	2.16	8%	0.3%	78	23.1	39.42	8.76	29%	1.2%	306	24.8	45.71	15	49%	13.1%			
2015	31.20	2.70	9%	0.5%	109	23.1	40.00	8.80	28%	1.2%	298	24.8	46.80	16	50%	13.6%			
2016	31.96	3.46	12%	0.7%	158	23.2	40.86	8.90	28%	1.2%	290	24.8	48.29	16	51%	14.2%			
2017	32.72	4.22	15%	0.9%	212	23.2	41.72	9.00	28%	1.2%	283	24.8	49.78	17	52%	14.8%			
2018	33.48	4.98	17%	1.2%	271	23.3	42.58	9.10	27%	1.1%	277	24.8	51.27	18	53%	15.3%			
2019	34.24	5.74	20%	1.5%	335	23.3	43.44	9.20	27%	1.1%	270	24.8	52.76	19	54%	15.9%			
2020	35.00	6.50	23%	1.8%	404	23.4	44.30	9.30	27%	1.1%	265	24.8	54.25	19	55%	16.4%			
2021	36.15	7.65	27%	2.2%	515	23.5	45.63	9.48	26%	1.1%	257	24.8	56.03	20	55%	16.4%			
2022	37.30	8.80	31%	2.8%	634	23.6	46.96	9.66	26%	1.0%	251	24.8	57.82	21	55%	16.4%			
2023	38.45	9.95	35%	3.3%	761	23.8	48.28	9.83	26%	1.0%	245	24.7	59.60	21	55%	16.4%			
2024	39.60	11.10	39%	3.9%	896	23.9	49.61	10.01	25%	1.0%	239	24.7	61.38	22	55%	16.4%			
2025	40.75	12.25	43%	4.5%	1,038	24.0	50.94	10.19	25%	1.0%	234	24.7	63.16	22	55%	16.4%			
2026	40.75	12.25	43%	4.5%	1,038	24.0	50.94	10.19	25%	1.0%	234	24.7	63.16	22	55%	16.4%			
2027	40.75	12.25	43%	4.5%	1,038	24.0	50.94	10.19	25%	1.0%	234	24.7	63.16	22	55%	16.4%			
2028	40.75	12.25	43%	4.5%	1,038	24.0	50.94	10.19	25%	1.0%	234	24.7	63.16	22	55%	16.4%			
2029	40.75	12.25	43%	4.5%	1,038	24.0	50.94	10.19	25%	1.0%	234	24.7	63.16	22	55%	16.4%			
2030	40.75	12.25	43%	4.5%	1,038	24.0	50.94	10.19	25%	1.0%	234	24.7	63.16	22	55%	16.4%			
2031	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			Change Coefficient
2032	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2033	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2034	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2035	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2036	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2037	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2038	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2039	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2040	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2041	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2042	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2043	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2044	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2045	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2046	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2047	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2048	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2049	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			
2050	40.75	12.25	43%	2.3%	519	23.5	50.94	10.19	25%	0.5%	117	24.6	63.16	22	55%	8.2%			

**Vehicle Technology Cost Projections--Light Trucks
Greening the Pump**

YEAR	ICE--Gasoline & Alt. Fuels (alcohol)					Diesel					Hybrid Electric					Gaseous fuel vehicles (LPG/CNG)		COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg		
	21.20	--		24,670		28.01			26,170		28.62				25,410	See Scenario data - values only spreadsheet		Baseline Values
2005	21.20	0%	0%	0	24.7	28.01	32%	1.6%	412	26.6	28.62	35%	7%	1,691	27.1			
2006	21.20	0%	0%	0	24.7	27.93	32%	1.5%	402	26.6	29.04	37%	7%	1,890	27.3			
2007	21.20	0%	0%	0	24.7	27.84	31%	1.5%	393	26.6	29.47	39%	8%	2,099	27.5			
2008	21.20	0%	0%	0	24.7	27.76	31%	1.5%	383	26.6	29.89	41%	9%	2,320	27.7			
2009	21.20	0%	0%	0	24.7	27.68	31%	1.4%	374	26.5	30.32	43%	10%	2,552	28.0			
2010	21.20	0%	0%	0	24.7	27.60	30%	1.4%	365	26.5	30.74	45%	11%	2,795	28.2			
2011	21.52	2%	0.1%	13	24.7	27.93	30%	1.4%	355	26.5	31.43	46%	12%	2,928	28.3			
2012	21.84	3%	0.1%	33	24.7	28.25	29%	1.3%	345	26.5	32.12	47%	12%	3,060	28.5			
2013	22.16	5%	0.2%	56	24.7	28.58	29%	1.3%	336	26.5	32.82	48%	13%	3,192	28.6			
2014	22.48	6%	0.3%	82	24.8	28.91	29%	1.2%	327	26.5	33.51	49%	13%	3,322	28.7			
2015	22.80	8%	0.4%	110	24.8	29.23	28%	1.2%	318	26.5	34.20	50%	14%	3,451	28.9			
2016	23.36	10%	0.7%	163	24.8	29.87	28%	1.2%	310	26.5	35.30	51%	14%	3,604	29.0			
2017	23.92	13%	0.9%	220	24.9	30.50	28%	1.2%	303	26.5	36.39	52%	15%	3,752	29.2			
2018	24.48	15%	1.1%	282	25.0	31.14	27%	1.1%	296	26.5	37.49	53%	15%	3,897	29.3			
2019	25.04	18%	1.4%	347	25.0	31.77	27%	1.1%	289	26.5	38.58	54%	16%	4,038	29.4			
2020	25.60	21%	1.7%	415	25.1	32.41	27%	1.1%	283	26.5	39.68	55%	16%	4,175	29.6			
2021	26.44	25%	2.1%	522	25.2	33.37	26%	1.1%	275	26.4	40.98	55%	16%	4,175	29.6			
2022	27.28	29%	2.6%	634	25.3	34.34	26%	1.0%	268	26.4	42.28	55%	16%	4,175	29.6			
2023	28.12	33%	3.0%	752	25.4	35.31	26%	1.0%	262	26.4	43.59	55%	16%	4,175	29.6			
2024	28.96	37%	3.5%	874	25.5	36.28	25%	1.0%	256	26.4	44.89	55%	16%	4,175	29.6			
2025	29.80	41%	4.1%	1,001	25.7	37.25	25%	1.0%	250	26.4	46.19	55%	16%	4,175	29.6			
2026	29.80	41%	4.1%	1,001	25.7	37.25	25%	1.0%	250	26.4	46.19	55%	16%	4,175	29.6			
2027	29.80	41%	4.1%	1,001	25.7	37.25	25%	1.0%	250	26.4	46.19	55%	16%	4,175	29.6			
2028	29.80	41%	4.1%	1,001	25.7	37.25	25%	1.0%	250	26.4	46.19	55%	16%	4,175	29.6			
2029	29.80	41%	4.1%	1,001	25.7	37.25	25%	1.0%	250	26.4	46.19	55%	16%	4,175	29.6			
2030	29.80	41%	4.1%	1,001	25.7	37.25	25%	1.0%	250	26.4	46.19	55%	16%	4,175	29.6			
2031	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			Change Coefficients
2032	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2033	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2034	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2035	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2036	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2037	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2038	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2039	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2040	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2041	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2042	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2043	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2044	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2045	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2046	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2047	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2048	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2049	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			
2050	29.80	41%	2.0%	500	25.2	37.25	25%	0.5%	125	26.3	46.19	55%	8%	2,088	27.5			

Vehicle Technology Cost Projections--Class 3-6 Trucks
Greening the Pump

YEAR	ICE--Gasoline & Alt. Fuels (alcohol)					Diesel					Hybrid Electric (gasoline)					Gaseous fuel vehicles (CNG/LPG)						COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, L/100 Km	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	
	7.20	--			33,818	8.00				37,623	9.61				38,902	35.1	6.71				41360	Baseline Values
2005	7.27	0%	0.0%	0	33.8	8.09	11%	0.2%	72	37.7	9.46	23%	2.9%	1,125	40.0	34.9	6.75	-20%	9.0%	3,737	41.4	
2006	7.37	1%	0.0%	15	33.8	8.19	11%	0.2%	72	37.7	9.65	24%	3.0%	1,179	40.1	34.42	6.84	-20%	9.0%	3,737	41.4	
2007	7.47	3%	0.1%	38	33.9	8.30	11%	0.2%	72	37.7	9.85	24%	3.2%	1,235	40.1	33.97	6.93	-20%	9.0%	3,737	41.4	
2008	7.57	4%	0.2%	65	33.9	8.41	11%	0.2%	72	37.7	10.05	25%	3.3%	1,293	40.2	33.52	7.02	-20%	9.0%	3,737	41.4	
2009	7.67	5%	0.3%	97	33.9	8.53	11%	0.2%	72	37.7	10.27	25%	3.5%	1,355	40.3	33.07	7.12	-20%	9.0%	3,737	41.4	
2010	7.77	7%	0.4%	132	34.0	8.64	11%	0.2%	72	37.7	10.49	26%	3.7%	1,420	40.3	32.6	7.22	-20%	9.0%	3,737	41.4	
2011	7.89	8%	0.5%	173	34.0	8.77	11%	0.2%	72	37.7	10.72	26%	3.8%	1,475	40.4	32.15	7.32	-20%	9.0%	3,737	41.4	
2012	8.00	10%	0.6%	218	34.0	8.90	11%	0.2%	73	37.7	10.95	27%	3.9%	1,533	40.4	31.67	7.43	-20%	9.0%	3,737	41.4	
2013	8.12	12%	0.8%	267	34.1	9.04	11%	0.2%	73	37.7	11.20	27%	4.1%	1,594	40.5	31.20	7.54	-20%	9.0%	3,737	41.4	
2014	8.25	13%	0.9%	319	34.1	9.18	11%	0.2%	73	37.7	11.46	28%	4.3%	1,658	40.6	30.73	7.66	-20%	9.0%	3,737	41.4	
2015	8.38	15%	1.1%	376	34.2	9.32	11%	0.2%	73	37.7	11.73	29%	4.4%	1,725	40.6	30.3	7.78	-20%	9.0%	3,737	41.4	
2016	8.50	17%	1.3%	433	34.3	9.46	11%	0.2%	73	37.7	11.90	29%	4.4%	1,725	40.6	29.81	7.90	-20%	9.0%	3,737	41.4	
2017	8.63	19%	1.5%	493	34.3	9.60	11%	0.2%	73	37.7	12.08	29%	4.4%	1,725	40.6	29.36	8.02	-20%	9.0%	3,737	41.4	
2018	8.76	20%	1.6%	558	34.4	9.75	11%	0.2%	73	37.7	12.27	29%	4.4%	1,725	40.6	28.91	8.14	-20%	9.0%	3,737	41.4	
2019	8.90	22%	1.9%	626	34.4	9.91	11%	0.2%	74	37.7	12.46	29%	4.4%	1,725	40.6	28.46	8.27	-20%	9.0%	3,737	41.4	
2020	9.04	24%	2.1%	699	34.5	10.07	11%	0.2%	74	37.7	12.66	29%	4.4%	1,725	40.6	28.0	8.40	-20%	9.0%	3,737	41.4	
2021	9.04	24%	2.1%	698	34.5	10.06	11%	0.2%	74	37.7	12.66	29%	4.4%	1,725	40.6	28.02	8.40	-20%	9.0%	3,737	41.4	
2022	9.04	24%	2.1%	697	34.5	10.06	11%	0.2%	74	37.7	12.65	29%	4.4%	1,725	40.6	28.02	8.40	-20%	9.0%	3,737	41.4	
2023	9.04	24%	2.1%	696	34.5	10.06	11%	0.2%	74	37.7	12.65	29%	4.4%	1,725	40.6	28.03	8.40	-20%	9.0%	3,737	41.4	
2024	9.03	24%	2.1%	695	34.5	10.06	11%	0.2%	74	37.7	12.65	29%	4.4%	1,725	40.6	28.04	8.40	-20%	9.0%	3,737	41.4	
2025	9.03	24%	2.1%	694	34.5	10.06	11%	0.2%	74	37.7	12.64	29%	4.4%	1,725	40.6	28.0	8.39	-20%	9.0%	3,737	41.4	
2026	9.03	24%	2.0%	693	34.5	10.05	11%	0.2%	74	37.7	12.64	29%	4.4%	1,725	40.6	28.05	8.39	-20%	9.0%	3,737	41.4	
2027	9.03	24%	2.0%	692	34.5	10.05	11%	0.2%	74	37.7	12.64	29%	4.4%	1,725	40.6	28.06	8.39	-20%	9.0%	3,737	41.4	
2028	9.03	24%	2.0%	691	34.5	10.05	11%	0.2%	74	37.7	12.64	29%	4.4%	1,725	40.6	28.06	8.39	-20%	9.0%	3,737	41.4	
2029	9.02	24%	2.0%	690	34.5	10.05	11%	0.2%	74	37.7	12.63	29%	4.4%	1,725	40.6	28.07	8.39	-20%	9.0%	3,737	41.4	
2030	9.02	24%	2.0%	689	34.5	10.04	11%	0.2%	74	37.7	12.63	29%	2.2%	863	39.8	28.1	8.38	-20%	5.7%	2,354	40.0	Change Coefficients
2031	9.02	24%	1.0%	344	34.2	10.04	11%	0.1%	37	37.7	12.63	29%	2.2%	863	39.8	28.08	8.38	-20%	5.7%	2,354	40.0	
2032	9.02	24%	1.0%	343	34.2	10.04	11%	0.1%	37	37.7	12.62	29%	2.2%	863	39.8	28.09	8.38	-20%	5.7%	2,354	40.0	
2033	9.01	24%	1.0%	343	34.2	10.04	11%	0.1%	37	37.7	12.62	29%	2.2%	863	39.8	28.10	8.38	-20%	5.7%	2,354	40.0	
2034	9.01	24%	1.0%	342	34.2	10.03	11%	0.1%	37	37.7	12.62	29%	2.2%	863	39.8	28.10	8.38	-20%	5.7%	2,354	40.0	
2035	9.01	24%	1.0%	341	34.2	10.03	11%	0.1%	37	37.7	12.61	29%	2.2%	863	39.8	28.1	8.37	-20%	5.7%	2,354	40.0	
2036	9.01	24%	1.0%	341	34.2	10.03	11%	0.1%	37	37.7	12.61	29%	2.2%	863	39.8	28.12	8.37	-20%	5.7%	2,354	40.0	
2037	9.01	24%	1.0%	340	34.2	10.03	11%	0.1%	37	37.7	12.61	29%	2.2%	863	39.8	28.12	8.37	-20%	5.7%	2,354	40.0	
2038	9.00	24%	1.0%	340	34.2	10.02	11%	0.1%	37	37.7	12.61	29%	2.2%	863	39.8	28.13	8.37	-20%	5.7%	2,354	40.0	
2039	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.14	8.37	-20%	5.7%	2,354	40.0	
2040	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.1	8.36	-20%	5.7%	2,354	40.0	
2041	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.14	8.36	-20%	5.7%	2,354	40.0	
2042	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.14	8.36	-20%	5.7%	2,354	40.0	
2043	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.14	8.36	-20%	5.7%	2,354	40.0	
2044	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.14	8.36	-20%	5.7%	2,354	40.0	
2045	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.1	8.36	-20%	5.7%	2,354	40.0	
2046	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.14	8.36	-20%	5.7%	2,354	40.0	
2047	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.14	8.36	-20%	5.7%	2,354	40.0	
2048	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.14	8.36	-20%	5.7%	2,354	40.0	
2049	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.14	8.36	-20%	5.7%	2,354	40.0	
2050	9.00	24%	1.0%	339	34.2	10.02	11%	0.1%	37	37.7	12.60	29%	2.2%	863	39.8	28.1	8.36	-20%	5.7%	2,354	40.0	

**Vehicle Technology Cost Projections--Class 7-8 Trucks
Greening the Pump**

YEAR	Diesel					Advanced Technology (LNG)					COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, L/100 Km	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	
	5.90	- -			130,000	39.87	5.90			145,000	Baseline Values
2005	5.90	0%	0.0%	0	130.0	40.73	5.78	-2%	15,000	145.0	
2006	5.90	0%	0.0%	0	130.0	40.73	5.78	-2%	15,000	145.0	
2007	5.90	0%	0.0%	0	130.0	40.74	5.78	-2%	15,000	145.0	
2008	5.90	0%	0.0%	0	130.0	40.74	5.78	-2%	15,000	145.0	
2009	5.90	0%	0.0%	0	130.0	40.74	5.78	-2%	15,000	145.0	
2010	5.90	0%	0.0%	0	130.0	40.75	5.78	-2%	15,000	145.0	
2011	6.02	2%	0.0%	8	130.0	39.92	5.90	0%	14,992	145.0	
2012	6.15	4%	0.0%	32	130.0	39.09	6.02	2%	14,968	145.0	
2013	6.28	6%	0.1%	73	130.1	38.26	6.15	4%	14,927	145.0	
2014	6.42	8%	0.1%	130	130.1	37.43	6.29	6%	14,870	145.0	
2015	6.57	10%	0.2%	203	130.2	36.60	6.43	8%	14,797	145.0	
2016	6.69	12%	0.2%	275	130.3	35.92	6.55	10%	14,725	145.0	
2017	6.82	13%	0.3%	359	130.4	35.25	6.68	12%	14,641	145.0	
2018	6.95	15%	0.3%	453	130.5	34.57	6.81	13%	14,547	145.0	
2019	7.09	17%	0.4%	558	130.6	33.89	6.95	15%	14,442	145.0	
2020	7.24	18%	0.5%	674	130.7	33.21	7.09	17%	14,326	145.0	
2021	7.24	18%	0.5%	674	130.7	33.21	7.09	17%	14,326	145.0	
2022	7.24	18%	0.5%	674	130.7	33.21	7.09	17%	14,326	145.0	
2023	7.24	18%	0.5%	674	130.7	33.21	7.09	17%	14,326	145.0	
2024	7.24	18%	0.5%	674	130.7	33.21	7.09	17%	14,326	145.0	
2025	7.24	18%	0.5%	674	130.7	33.21	7.09	17%	14,326	145.0	
2026	7.24	18%	0.5%	674	130.7	33.21	7.09	17%	14,326	145.0	
2027	7.24	18%	0.5%	675	130.7	33.21	7.09	17%	14,325	145.0	
2028	7.24	18%	0.5%	675	130.7	33.21	7.09	17%	14,325	145.0	
2029	7.24	18%	0.5%	675	130.7	33.21	7.09	17%	14,325	145.0	
2030	7.24	18%	0.5%	675	130.7	33.20	7.09	17%	14,325	145.0	
2031	7.24	18%	0.3%	338	130.3	33.20	7.09	17%	14,662	145.0	Change Coefficients
2032	7.24	18%	0.3%	338	130.3	33.20	7.09	17%	9,245	145.0	
2033	7.24	18%	0.3%	338	130.3	33.20	7.09	17%	9,245	145.0	
2034	7.24	18%	0.3%	338	130.3	33.20	7.09	17%	9,245	145.0	
2035	7.24	18%	0.3%	338	130.3	33.20	7.09	17%	9,245	145.0	
2036	7.24	18%	0.3%	339	130.3	33.19	7.09	17%	9,245	145.0	
2037	7.24	18%	0.3%	339	130.3	33.19	7.09	17%	9,244	145.0	
2038	7.24	18%	0.3%	339	130.3	33.19	7.09	17%	9,244	145.0	
2039	7.24	18%	0.3%	339	130.3	33.19	7.09	17%	9,244	145.0	
2040	7.24	18%	0.3%	339	130.3	33.18	7.09	17%	9,244	145.0	
2041	7.24	18%	0.3%	340	130.3	33.18	7.09	17%	9,244	145.0	
2042	7.24	18%	0.3%	340	130.3	33.18	7.09	17%	9,244	145.0	
2043	7.24	19%	0.3%	340	130.3	33.18	7.09	17%	9,244	145.0	
2044	7.25	19%	0.3%	340	130.3	33.18	7.10	17%	9,244	145.0	
2045	7.25	19%	0.3%	340	130.3	33.17	7.10	17%	9,243	145.0	
2046	7.25	19%	0.3%	341	130.3	33.17	7.10	17%	9,243	145.0	
2047	7.25	19%	0.3%	341	130.3	33.17	7.10	17%	9,243	145.0	
2048	7.25	19%	0.3%	341	130.3	33.17	7.10	17%	9,243	145.0	
2049	7.25	19%	0.3%	341	130.3	33.17	7.10	17%	9,243	145.0	
2050	7.25	19%	0.3%	341	130.3	33.16	7.10	17%	9,243	145.0	

**Vehicle Technology Cost Projections--Autos
Go Your Own Way**

YEAR	ICE--Gasoline						Diesel						Hybrid Electric (Gasoline & E-85)						COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$ x 1000	Total Technology Cost, US \$	Fuel Economy, mpg	Incremental Fuel Economy Improvement, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$ x 1000	Total Technology Cost, US \$	
	28.50	- -			23,000		37.65				24,500		38.48				24,288		Baseline Values
2005	28.50	0.00	0%	0.0%	0	23.0	37.65	9.15	32%	1.6%	386	24.9	38.48	10	35%	6.7%	1,616	25.9	
2006	28.60	0.10	0%	0.0%	1	23.0	37.78	9.18	32%	1.6%	386	24.9	39.05	10	37%	7.2%	1,760	26.0	
2007	28.70	0.20	1%	0.0%	2	23.0	37.91	9.21	32%	1.6%	386	24.9	39.62	11	38%	7.9%	1,908	26.2	
2008	28.80	0.30	1%	0.0%	4	23.0	38.04	9.24	32%	1.6%	386	24.9	40.19	11	40%	8.5%	2,062	26.3	
2009	28.90	0.40	1%	0.0%	6	23.0	38.18	9.28	32%	1.6%	386	24.9	40.76	12	41%	9.1%	2,220	26.5	
2010	29.00	0.50	2%	0.0%	9	23.0	38.31	9.31	32%	1.6%	386	24.9	41.33	12	43%	9.8%	2,383	26.7	
2011	29.40	0.90	3%	0.1%	21	23.0	38.84	9.44	32%	0.8%	193	24.7	42.36	13	44%	10.6%	2,564	26.9	
2012	29.80	1.30	5%	0.2%	37	23.0	39.37	9.57	32%	0.8%	193	24.7	43.40	14	46%	11.3%	2,746	27.0	
2013	30.20	1.70	6%	0.2%	55	23.1	39.89	9.69	32%	0.8%	193	24.7	44.43	14	47%	12.1%	2,929	27.2	
2014	30.60	2.10	7%	0.3%	75	23.1	40.42	9.82	32%	0.8%	193	24.7	45.47	15	49%	12.8%	3,113	27.4	
2015	31.00	2.50	9%	0.4%	97	23.1	40.95	9.95	32%	0.8%	193	24.7	46.50	16	50%	13.6%	3,298	27.6	
2016	31.40	2.90	10%	0.5%	121	23.1	40.95	9.55	30%	0.7%	173	24.7	48.05	17	53%	15.3%	3,710	28.0	
2017	31.80	3.30	12%	0.6%	147	23.1	40.95	9.15	29%	0.6%	155	24.7	49.60	18	56%	17.0%	4,134	28.4	
2018	32.20	3.70	13%	0.8%	174	23.2	40.95	8.75	27%	0.6%	138	24.6	51.15	19	59%	18.8%	4,569	28.9	
2019	32.60	4.10	14%	0.9%	203	23.2	40.95	8.35	26%	0.5%	123	24.6	52.70	20	62%	20.6%	5,015	29.3	
2020	33.00	4.50	16%	1.0%	233	23.2	0.00						54.25	21	64%	22.5%	5,471	29.8	
2021	33.30	4.80	17%	0.6%	128	23.1	0.00						54.10	21	62%	10.6%	2,572	26.9	Change Coefficient
2022	33.60	5.10	18%	0.6%	141	23.1	0.00						53.94	20	61%	10.0%	2,417	26.7	
2023	33.90	5.40	19%	0.7%	153	23.2	0.00						53.79	20	59%	9.3%	2,270	26.6	
2024	34.20	5.70	20%	0.7%	166	23.2	0.00						53.63	19	57%	8.8%	2,129	26.4	
2025	34.50	6.00	21%	0.8%	179	23.2	0.00						53.48	19	55%	8.2%	1,995	26.3	
2026	34.70	6.20	22%	0.8%	188	23.2	0.00						53.79	19	55%	8.2%	1,995	26.3	
2027	34.90	6.40	22%	0.9%	197	23.2	0.00						54.10	19	55%	8.2%	1,995	26.3	
2028	35.10	6.60	23%	0.9%	207	23.2	0.00						54.41	19	55%	8.2%	1,995	26.3	
2029	35.30	6.80	24%	0.9%	216	23.2	0.00						54.72	19	55%	8.2%	1,995	26.3	
2030	35.50	7.00	25%	1.0%	225	23.2	0.00						55.03	20	55%	8.2%	1,995	26.3	
2031	35.70	7.20	25%	0.3%	59	23.1	0.00						55.34	20	55%	2.1%	499	24.8	Change Coefficient
2032	35.90	7.40	26%	0.3%	61	23.1	0.00						55.65	20	55%	2.1%	499	24.8	
2033	36.10	7.60	27%	0.3%	64	23.1	0.00						55.96	20	55%	2.1%	499	24.8	
2034	36.30	7.80	27%	0.3%	66	23.1	0.00						56.27	20	55%	2.1%	499	24.8	
2035	36.50	8.00	28%	0.3%	69	23.1	0.00						56.58	20	55%	2.1%	499	24.8	
2036	36.50	8.00	28%	0.3%	69	23.1	0.00						56.58	20	55%	2.1%	499	24.8	
2037	36.50	8.00	28%	0.3%	69	23.1	0.00						56.58	20	55%	2.1%	499	24.8	
2038	36.50	8.00	28%	0.3%	69	23.1	0.00						56.58	20	55%	2.1%	499	24.8	
2039	36.50	8.00	28%	0.3%	69	23.1	0.00						56.58	20	55%	2.1%	499	24.8	
2040	36.50	8.00	28%	0.3%	69	23.1	0.00						56.58	20	55%	2.1%	499	24.8	
2041	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	Change Coefficient
2042	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	
2043	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	
2044	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	
2045	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	
2046	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	
2047	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	
2048	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	
2049	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	
2050	36.50	8.00	28%	0.0%	9	23.0	0.00						56.58	20	55%	0.3%	62	24.4	

**Vehicle Technology Cost Projections--Autos
Go Your Own Way**

YEAR	Fuel Cells						COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	
	55.80	--			26,404		Baseline Values
2005				0.0%	0		
2006				0.0%	0		
2007				0.0%	0		
2008				0.0%	0		
2009				0.0%	0		
2010				0.0%	0		
2011	55.80			0.0%	0	26.4	
2012	55.80			0.0%	0	26.4	
2013	55.80			0.0%	0	26.4	
2014	55.80			0.0%	0	26.4	
2015	55.80	24.80	80%	21.9%	5,790	32.2	
2016	57.18	25.78	82%	22.6%	5,975	32.4	
2017	58.56	26.76	84%	23.3%	6,156	32.6	
2018	59.94	27.74	86%	24.0%	6,333	32.7	
2019	61.32	28.72	88%	24.6%	6,507	32.9	
2020	62.70	29.70	90%	25.3%	6,677	33.1	
2021	63.96	30.66	92%	13.0%	3,432	29.8	Change Coefficient
2022	65.22	31.62	94%	13.3%	3,524	29.9	
2023	66.48	32.58	96%	13.7%	3,615	30.0	
2024	67.74	33.54	98%	14.0%	3,705	30.1	
2025	69.00	34.50	100%	14.4%	3,793	30.2	
2026	70.11	35.41	102%	14.7%	3,887	30.3	
2027	71.22	36.32	104%	15.1%	3,981	30.4	
2028	72.33	37.23	106%	15.4%	4,073	30.5	
2029	73.44	38.14	108%	15.8%	4,165	30.6	
2030	74.55	39.05	110%	16.1%	4,257	30.7	
2031	75.70	40.00	112%	4.1%	1,088	27.5	Change Coefficient
2032	76.85	40.95	114%	4.2%	1,112	27.5	
2033	78.00	41.90	116%	4.3%	1,136	27.5	
2034	79.15	42.85	118%	4.4%	1,159	27.6	
2035	80.30	43.80	120%	4.5%	1,182	27.6	
2036	80.30	43.80	120%	4.5%	1,182	27.6	
2037	80.30	43.80	120%	4.5%	1,182	27.6	
2038	80.30	43.80	120%	4.5%	1,182	27.6	
2039	80.30	43.80	120%	4.5%	1,182	27.6	
2040	80.30	43.80	120%	4.5%	1,182	27.6	
2041	80.30	43.80	120%	0.6%	148	26.6	Change Coefficient
2042	80.30	43.80	120%	0.6%	148	26.6	
2043	80.30	43.80	120%	0.6%	148	26.6	
2044	80.30	43.80	120%	0.6%	148	26.6	
2045	80.30	43.80	120%	0.6%	148	26.6	
2046	80.30	43.80	120%	0.6%	148	26.6	
2047	80.30	43.80	120%	0.6%	148	26.6	
2048	80.30	43.80	120%	0.6%	148	26.6	
2049	80.30	43.80	120%	0.6%	148	26.6	
2050	80.30	43.80	120%	0.6%	148	26.6	

Vehicle Technology Cost Projections--Light Trucks
Go Your Own Way

YEAR	ICE--Gasoline					Diesel					Hybrid Electric (Gasoline & E-85)					COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, mpg	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	
	21.20	--		24,670		28.01			26,170		28.62			25,410		Baseline Values
2005	21.20	0%	0%	0	24.7	28.01	32%	1.6%	412	26.6	28.62	35%	6.7%	1,691	27.1	
2006	21.28	0%	0%	2	24.7	28.11	32%	1.6%	412	26.6	29.16	37%	7.4%	1,893	27.3	
2007	21.36	1%	0%	5	24.7	28.22	32%	1.6%	412	26.6	29.70	39%	8.3%	2,104	27.5	
2008	21.44	1%	0%	9	24.7	28.32	32%	1.6%	412	26.6	30.24	41%	9.2%	2,325	27.7	
2009	21.52	2%	0%	13	24.7	28.43	32%	1.6%	412	26.6	30.78	43%	10.1%	2,556	28.0	
2010	21.60	2%	0%	18	24.7	28.53	32%	1.6%	412	26.6	31.32	45%	11.0%	2,795	28.2	
2011	21.89	3%	0%	36	24.7	28.92	32%	1.6%	412	26.6	31.97	46%	11.5%	2,927	28.3	
2012	22.18	5%	0%	58	24.7	29.30	32%	1.6%	412	26.6	32.62	47%	12.0%	3,059	28.5	
2013	22.47	6%	0%	81	24.8	29.68	32%	1.6%	412	26.6	33.27	48%	12.6%	3,190	28.6	
2014	22.76	7%	0%	106	24.8	30.07	32%	1.6%	412	26.6	33.92	49%	13.1%	3,321	28.7	
2015	23.05	9%	1%	133	24.8	30.45	32%	1.6%	412	26.6	34.58	50%	13.6%	3,451	28.9	
2016	23.35	10%	1%	162	24.8	30.45	30%	1.4%	370	26.5	35.27	51%	14.2%	3,597	29.0	
2017	23.65	12%	1%	192	24.9	30.45	29%	1.3%	331	26.5	35.97	52%	14.7%	3,743	29.2	
2018	23.95	13%	1%	224	24.9	30.45	27%	1.1%	294	26.5	36.66	53%	15.3%	3,888	29.3	
2019	24.25	14%	1%	256	24.9	30.45	26%	1.0%	261	26.4	37.36	54%	15.9%	4,032	29.4	
2020	24.55	16%	1%	290	25.0						38.05	55%	16.4%	4,175	29.6	
2021	24.77	17%	1%	158	24.8						38.39	55%	8.2%	2,088	27.5	Change Coef.
2022	24.99	18%	1%	170	24.8						38.73	55%	8.2%	2,088	27.5	
2023	25.21	19%	1%	184	24.9						39.08	55%	8.2%	2,088	27.5	
2024	25.43	20%	1%	197	24.9						39.42	55%	8.2%	2,088	27.5	
2025	25.65	21%	1%	210	24.9						39.76	55%	8.2%	2,088	27.5	
2026	25.80	22%	1%	220	24.9						39.99	55%	8.2%	2,088	27.5	
2027	25.95	22%	1%	229	24.9						40.22	55%	8.2%	2,088	27.5	
2028	26.10	23%	1%	239	24.9						40.46	55%	8.2%	2,088	27.5	
2029	26.25	24%	1%	249	24.9						40.69	55%	8.2%	2,088	27.5	
2030	26.40	25%	1%	258	24.9						40.92	55%	8.2%	2,088	27.5	
2031	26.55	25%	0%	67	24.7						41.15	55%	2.1%	522	25.9	Change Coef.
2032	26.70	26%	0%	70	24.7						41.39	55%	2.1%	522	25.9	
2033	26.85	27%	0%	72	24.7						41.62	55%	2.1%	522	25.9	
2034	27.00	27%	0%	75	24.7						41.85	55%	2.1%	522	25.9	
2035	27.15	28%	0%	77	24.7						42.08	55%	2.1%	522	25.9	
2036	27.15	28%	0%	77	24.7						42.08	55%	2.1%	522	25.9	
2037	27.15	28%	0%	77	24.7						42.08	55%	2.1%	522	25.9	
2038	27.15	28%	0%	77	24.7						42.08	55%	2.1%	522	25.9	
2039	27.15	28%	0%	77	24.7						42.08	55%	2.1%	522	25.9	
2040	27.15	28%	0%	77	24.7						42.08	55%	2.1%	522	25.9	
2041	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	Change Coef.
2042	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	
2043	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	
2044	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	
2045	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	
2046	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	
2047	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	
2048	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	
2049	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	
2050	27.15	28%	0%	10	24.7						42.08	55%	0.3%	65	25.5	

**Vehicle Technology Cost Projections--Light Trucks
Go Your Own Way**

YEAR	Fuel Cells						COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	
	21.20	--			27,112		Baseline Values
2005				0.0%	0		
2006				0.0%	0		
2007				0.0%	0		
2008				0.0%	0		
2009				0.0%	0		
2010				0.0%	0		
2011	41.49	18.44	90%	18.3%	4,960	32.1	
2012	41.49	18.44	87%	17.7%	4,811	31.9	
2013	41.49	18.44	85%	17.2%	4,666	31.8	
2014	41.49	18.44	82%	16.7%	4,525	31.6	
2015	41.49	18.44	80%	16.2%	4,388	31.5	
2016	42.52	19.17	82%	16.6%	4,514	31.6	
2017	43.55	19.90	84%	17.1%	4,636	31.7	
2018	44.58	20.63	86%	17.5%	4,756	31.9	
2019	45.61	21.36	88%	18.0%	4,873	32.0	
2020	46.65	22.10	90%	18.4%	4,988	32.1	
2021	47.58	22.81	92%	9.4%	2,556	29.7	Change Coefficient
2022	48.51	23.52	94%	9.7%	2,618	29.7	
2023	49.44	24.23	96%	9.9%	2,678	29.8	
2024	50.37	24.94	98%	10.1%	2,738	29.9	
2025	51.30	25.65	100%	10.3%	2,797	29.9	
2026	52.13	26.33	102%	10.5%	2,859	30.0	
2027	52.96	27.01	104%	10.8%	2,921	30.0	
2028	53.78	27.68	106%	11.0%	2,982	30.1	
2029	54.61	28.36	108%	11.2%	3,042	30.2	
2030	55.44	29.04	110%	11.4%	3,102	30.2	
2031	56.30	29.75	112%	2.9%	791	27.9	Change Coefficient
2032	57.16	30.46	114%	3.0%	807	27.9	
2033	58.01	31.16	116%	3.0%	822	27.9	
2034	58.87	31.87	118%	3.1%	837	27.9	
2035	59.73	32.58	120%	3.1%	852	28.0	
2036	59.73	32.58	120%	3.1%	852	28.0	
2037	59.73	32.58	120%	3.1%	852	28.0	
2038	59.73	32.58	120%	3.1%	852	28.0	
2039	59.73	32.58	120%	3.1%	852	28.0	
2040	59.73	32.58	120%	3.1%	852	28.0	
2041	59.73	32.58	120%	0.4%	107	27.2	Change Coefficient
2042	59.73	32.58	120%	0.4%	107	27.2	
2043	59.73	32.58	120%	0.4%	107	27.2	
2044	59.73	32.58	120%	0.4%	107	27.2	
2045	59.73	32.58	120%	0.4%	107	27.2	
2046	59.73	32.58	120%	0.4%	107	27.2	
2047	59.73	32.58	120%	0.4%	107	27.2	
2048	59.73	32.58	120%	0.4%	107	27.2	
2049	59.73	32.58	120%	0.4%	107	27.2	
2050	59.73	32.58	120%	0.4%	107	27.2	

Vehicle Technology Cost Projections--Class 3-6 Trucks
Go Your Own Way

YEAR	ICE--Gasoline					Diesel					Hybrid Electric (gasoline)					Fuel Cell					COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	
	8.20	--			33,818	8.60				37,623					38,902					40,821	Baseline Values
2005	8.20	0%	0.0%	0	33.8	8.60	5%	0.0%	14	37.6			0.0%	0					0		
2006	8.36	2%	0.1%	25	33.8	8.88	6%	0.1%	22	37.6			0.0%	0					0		
2007	8.52	4%	0.2%	63	33.9	9.16	8%	0.1%	32	37.7			0.0%	0					0		
2008	8.68	6%	0.3%	108	33.9	9.44	9%	0.1%	44	37.7			0.0%	0					0		
2009	8.84	8%	0.5%	157	34.0	9.72	10%	0.2%	57	37.7			0.0%	0					0		
2010	9.00	10%	0.6%	211	34.0	10.00	11%	0.2%	71	37.7	11.70	30%	4.9%	1,902	40.8				0		
2011	9.16	12%	0.8%	268	34.1	10.30	12%	0.2%	89	37.7	12.10	32%	5.6%	2,177	41.1	14.76	61%	12.1%	4,932	45.8	
2012	9.32	14%	1.0%	328	34.1	10.60	14%	0.3%	108	37.7	12.50	34%	6.3%	2,460	41.4	14.76	58%	11.5%	4,690	45.5	
2013	9.48	16%	1.2%	391	34.2	10.90	15%	0.3%	129	37.8	12.90	36%	7.1%	2,750	41.7	14.76	56%	10.9%	4,457	45.3	
2014	9.64	18%	1.3%	456	34.3	11.20	16%	0.4%	151	37.8	13.30	38%	7.8%	3,046	41.9	14.76	53%	10.4%	4,232	45.1	
2015	10.00	22%	1.8%	612	34.4	11.50	15%	0.3%	129	37.8	13.70	37%	7.4%	2,893	41.8	14.76	48%	9.2%	3,757	44.6	
2016	10.20	24%	2.1%	703	34.5	11.90	17%	0.4%	160	37.8	14.15	39%	8.1%	3,169	42.1	15.23	49%	9.6%	3,903	44.7	
2017	10.40	27%	2.4%	797	34.6	12.30	18%	0.5%	192	37.8	14.60	40%	8.9%	3,446	42.3	15.70	51%	9.9%	4,043	44.9	
2018	10.60	29%	2.6%	893	34.7	12.70	20%	0.6%	226	37.8	15.05	42%	9.6%	3,724	42.6	16.16	52%	10.2%	4,179	45.0	
2019	10.80	32%	2.9%	992	34.8	13.10	21%	0.7%	261	37.9	15.50	44%	10.3%	4,002	42.9	16.63	54%	10.6%	4,309	45.1	
2020	11.00	34%	3.2%	1,094	34.9	13.50	23%	0.8%	297	37.9	15.95	45%	11.0%	4,279	43.2	17.10	55%	10.9%	4,436	45.3	
2021	11.20	37%	1.8%	599	34.4	13.80	23%	0.4%	155	37.8	16.36	46%	5.8%	2,243	41.1	17.68	58%	7.9%	2,334	44.1	Change Coefficients
2022	11.40	39%	1.9%	652	34.5	14.10	24%	0.4%	161	37.8	16.77	47%	6.0%	2,344	41.2	18.26	60%	8.3%	3,376	44.2	
2023	11.60	41%	2.1%	706	34.5	14.40	24%	0.4%	167	37.8	17.18	48%	6.3%	2,445	41.3	18.84	62%	8.6%	3,512	44.3	
2024	11.80	44%	2.3%	761	34.6	14.70	25%	0.5%	174	37.8	17.59	49%	6.5%	2,544	41.4	19.42	65%	8.9%	3,645	44.5	
2025	12.00	46%	2.4%	817	34.6	15.00	25%	0.5%	180	37.8	18.00	50%	6.8%	2,641	41.5	20.00	67%	9.2%	3,773	44.6	
2026	12.20	49%	2.6%	874	34.7	15.30	25%	0.5%	186	37.8	18.30	50%	6.8%	2,641	41.5	20.40	67%	9.3%	3,807	44.6	
2027	12.40	51%	2.8%	932	34.8	15.60	26%	0.5%	191	37.8	18.60	50%	6.8%	2,641	41.5	20.80	68%	9.4%	3,840	44.7	
2028	12.60	54%	2.9%	991	34.8	15.90	26%	0.5%	197	37.8	18.90	50%	6.8%	2,641	41.5	21.20	68%	9.5%	3,871	44.7	
2029	12.80	56%	3.1%	1,051	34.9	16.20	27%	0.5%	203	37.8	19.20	50%	6.8%	2,641	41.5	21.60	69%	9.6%	3,902	44.7	
2030	13.00	59%	3.3%	1,111	34.9	16.50	27%	0.6%	208	37.8	19.50	50%	6.8%	2,641	41.5	22.00	69%	9.6%	3,931	44.8	
2031	13.00	59%	0.8%	278	34.1	16.70	28%	0.2%	58	37.7	19.50	50%	1.7%	660	39.6	22.40	72%	2.5%	1,030	41.9	Change Coefficients
2032	13.00	59%	0.8%	278	34.1	16.90	30%	0.2%	65	37.7	19.50	50%	1.7%	660	39.6	22.80	75%	2.6%	1,078	41.9	
2033	13.00	59%	0.8%	278	34.1	17.10	32%	0.2%	71	37.7	19.50	50%	1.7%	660	39.6	23.20	78%	2.8%	1,126	41.9	
2034	13.00	59%	0.8%	278	34.1	17.30	33%	0.2%	79	37.7	19.50	50%	1.7%	660	39.6	23.60	82%	2.9%	1,174	42.0	
2035	13.00	59%	0.8%	278	34.1	17.50	35%	0.2%	86	37.7	19.50	50%	1.7%	660	39.6	24.00	85%	3.0%	1,222	42.0	
2036	13.00	59%	0.8%	278	34.1	17.50	35%	0.2%	86	37.7	19.50	50%	1.7%	660	39.6	24.40	88%	3.1%	1,271	42.1	
2037	13.00	59%	0.8%	278	34.1	17.50	35%	0.2%	86	37.7	19.50	50%	1.7%	660	39.6	24.80	91%	3.2%	1,319	42.1	
2038	13.00	59%	0.8%	278	34.1	17.50	35%	0.2%	86	37.7	19.50	50%	1.7%	660	39.6	25.20	94%	3.4%	1,368	42.2	
2039	13.00	59%	0.8%	278	34.1	17.50	35%	0.2%	86	37.7	19.50	50%	1.7%	660	39.6	25.60	97%	3.5%	1,417	42.2	
2040	13.00	59%	0.8%	278	34.1	17.50	35%	0.2%	86	37.7	19.50	50%	1.7%	660	39.6	26.00	100%	3.6%	1,466	42.3	
2041	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	Change Coefficients
2042	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	
2043	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	
2044	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	
2045	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	
2046	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	
2047	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	
2048	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	
2049	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	
2050	13.00	59%	0.1%	35	33.9	17.50	35%	0.0%	11	37.6	19.50	50%	0.2%	83	39.0	26.00	100%	0.4%	183	41.0	

**Vehicle Technology Cost Projections--Class 7-8 Trucks
Go Your Own Way**

YEAR	Conventional Diesel					Super Diesel					COMMENTS
	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	Fuel Economy, mpg	Incremental Fuel Economy Improvement, %	Incremental Technology Cost, %	Incremental Technology Cost, US \$	Total Technology Cost, US \$ x 1000	
	6.00	- -			130,000	6.00				130,000	Baseline Values
2005	6.00	0%	0.0%	0	130.0				0		
2006	6.20	3%	0.0%	22	130.0				0		
2007	6.40	7%	0.1%	88	130.1				0		
2008	6.60	10%	0.2%	199	130.2				0		
2009	6.80	13%	0.3%	353	130.4				0		
2010	7.00	17%	0.4%	552	130.6				0		
2011	7.20	20%	0.6%	795	130.8	9.00	50%	3.8%	4,966	135.0	
2012	7.40	23%	0.8%	1,081	131.1	9.00	50%	3.8%	4,966	135.0	
2013	7.60	27%	1.1%	1,413	131.4	9.00	50%	3.8%	4,966	135.0	
2014	7.80	30%	1.4%	1,788	131.8	9.00	50%	3.8%	4,966	135.0	
2015	8.00	33%	1.7%	2,207	132.2	9.00	50%	3.8%	4,966	135.0	
2016	8.20	37%	2.1%	2,671	132.7	9.20	53%	4.3%	5,650	135.7	
2017	8.40	40%	2.4%	3,178	133.2	9.40	57%	4.9%	6,379	136.4	
2018	8.60	43%	2.9%	3,730	133.7	9.60	60%	5.5%	7,151	137.2	
2019	8.80	47%	3.3%	4,326	134.3	9.80	63%	6.1%	7,968	138.0	
2020	9.00	50%	3.8%	4,966	135.0	10.00	67%	6.8%	8,828	138.8	
2021	9.20	53%	2.2%	2,825	132.8	10.25	71%	3.8%	4,983	135.0	Change Coefficients
2022	9.40	57%	2.5%	3,189	133.2	10.50	75%	4.3%	5,587	135.6	
2023	9.60	60%	2.8%	3,576	133.6	10.75	79%	4.8%	6,225	136.2	
2024	9.80	63%	3.1%	3,984	134.0	11.00	83%	5.3%	6,897	136.9	
2025	10.00	67%	3.4%	4,414	134.4	11.25	88%	5.8%	7,604	137.6	
2026	10.00	67%	3.4%	4,414	134.4	11.50	92%	6.4%	8,346	138.3	
2027	10.00	67%	3.4%	4,414	134.4	11.75	96%	7.0%	9,122	139.1	
2028	10.00	67%	3.4%	4,414	134.4	12.00	100%	7.6%	9,932	139.9	
2029	10.00	67%	3.4%	4,414	134.4	12.25	104%	8.3%	10,777	140.8	
2030	10.00	67%	3.4%	4,414	134.4	12.50	108%	9.0%	11,656	141.7	
2031	10.00	67%	0.8%	1,104	131.1	12.60	110%	2.3%	3,004	133.0	Change Coefficients
2032	10.00	67%	0.8%	1,104	131.1	12.70	112%	2.4%	3,096	133.1	
2033	10.00	67%	0.8%	1,104	131.1	12.80	113%	2.5%	3,189	133.2	
2034	10.00	67%	0.8%	1,104	131.1	12.90	115%	2.5%	3,284	133.3	
2035	10.00	67%	0.8%	1,104	131.1	13.00	117%	2.6%	3,380	133.4	
2036	10.00	67%	0.8%	1,104	131.1	13.00	117%	2.6%	3,380	133.4	
2037	10.00	67%	0.8%	1,104	131.1	13.00	117%	2.6%	3,380	133.4	
2038	10.00	67%	0.8%	1,104	131.1	13.00	117%	2.6%	3,380	133.4	
2039	10.00	67%	0.8%	1,104	131.1	13.00	117%	2.6%	3,380	133.4	
2040	10.00	67%	0.8%	1,104	131.1	13.00	117%	2.6%	3,380	133.4	
2041	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	Change Coefficients
2042	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	
2043	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	
2044	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	
2045	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	
2046	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	
2047	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	
2048	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	
2049	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	
2050	10.00	67%	0.1%	138	130.1	13.00	117%	0.3%	422	130.4	